high volume manufacturing (HVM) processes. The characteristics of the absorber, such as pore diameter, pore density, sheet thickness and air layer thickness determine the absorption behavior. The acoustic absorption curve typically shows a peak in a certain frequency range, and the location and the width of this peak can be controlled with these parameters. This can be done in a passive sense, e.g. a static mechanical design, but more complex solutions are also possible as mentioned above where the air layer **106** is dynamically adjusted to shift the sound absorption in case of large fan speed variations. This allows the absorber solution to be tailored to absorb the noise generated by the fan or other noise sources.

[0021] The new micro porous panel absorber **104** allows ultra thin designs that are more than 25 times thinner than existing foam type solutions. Therefore it can be integrated into blowers, axial fans, notebooks, CE devices, desktops, servers or mobile internet devices. It also does not require new materials, and as opposed to for example open cell foams, does not have a negative impact on the airflow because the pore diameter is so small.

[0022] FIG. **2** shows a graph comparing foam absorbers to the micro porous absorber of the present invention. A value of zero means that no energy is absorbed, while a value of 1 means that all energy is absorbed. The graph shows a comparison with an open cell foam material of 32 mm thick. The results show that the micro porous panel absorber has approximately the same absorption, but is only 1.25 mm thick as compared to the 32 mm thick foam. The peak at which the maximum absorption occurs and the width of this peak can be controlled by adjusting the values for the pore diameter, the pore density, the sheet thickness and the air layer thickness. Thus, the micro porous panel absorber allows ultra thin designs that can be integrated into blowers or notebooks.

[0023] Referring to FIG. **3**, embodiments of the invention also include optimizing fan design to be used in conjunction with the micro porous absorbers. Current and future notebook cooling solutions use a regular radial blower or cross flow blower to deliver airflow to the system. As shown, a radial cross-flow blower **301** has an air intake **300** through the top and/or bottom, and an air outlet on the side. In the center of the blower a blade rotor **302** rotates to draw air in the inlet **300** and push it out of the outlet **304**. The cross flow blower **301** uses a side-in side-out concept, which is especially suited for ultra thin form factors where there is very little space for the top or bottom clearances required for a regular blower. Embodiments of the invention disclose an optimized integrated design, comprising an optimized rotor design, coupled with an integrated noise control solution using a micro porous panel absorber.

[0024] Numerical simulations and experiments have shown that an optimal blade number exists for a given rotor. FIG. **4**A shows a 20-blade rotor and FIG. **4**B shows a 27-blade rotor, as examples. FIG. **5** is a graph showing air pressure verses flow rate for both the 20-blade and 27 blade rotors. The blade pass frequency is determined by the rotational speed of the fan and the number of blades. Optimizing the rotor blade number may lead to an airflow increase of about 10%. The fan rotation will result in an acoustic noise spectrum containing distinct peaks at the blade pass frequency and the higher harmonics. This was experimentally confirmed by comparing a standard 20 blade rotor to a **27** blade rotor for the cross flow blower. The simulations show that the optimal blade number for these types of rotors is approximately 25.

[0025] FIG. **6** is a graph illustrating the fan noise spectrum of a cross flow blower. The blade pass frequency at which most noise occurs is determined by the rotational speed of the fan, RPM, and the number of blades, N:

$$f_{BPF}=(\mathrm{RPM}*N)/60$$

[0026] The micro porous panel absorber design is now designed and integrated to work exactly at the main blade pass frequency.

[0027] An example of such an integration is shown in FIGS. **1**B and **1**C discussed above where the top cover of the blower is replaced by a micro perforated panel, backed by an air layer. The noise reduction performance of this sample was measured experimentally. The results are given in FIG. **7** which shows various noise reductions at different frequencies. The graph shows that there is very significant absorption of up to 6 dB in the ⅓ octave bands for which the absorber was designed. Interestingly, it also provides significant noise reduction at the second harmonic of this frequency. The absorber could also be integrated into the side walls of the blower or system to allow the thinnest system possible.

[0028] The application of the integrated and tuned micro porous absorbers is not limited to cooling fans. Other applications involve integration into chassis, casing or enclosure designs, heat exchanger designs using perforated fins with the separating air layers as micro porous absorbers. Also, an active concept may be used where the air layer thickness is adjusted automatically using an actuator mechanism. The rotor speed and the acoustic noise levels can be sensed and made available to the system to allow such an active absorber design.

[0029] The above description of illustrated embodiments of the invention, including what is described in the Abstract, is not intended to be exhaustive or to limit the invention to the precise forms disclosed. While specific embodiments of, and examples for, the invention are described herein for illustrative purposes, various equivalent modifications are possible within the scope of the invention, as those skilled in the relevant art will recognize.

[0030] These modifications can be made to the invention in light of the above detailed description. The terms used in the following claims should not be construed to limit the invention to the specific embodiments disclosed in the specification and the claims. Rather, the scope of the invention is to be determined entirely by the following claims, which are to be construed in accordance with established doctrines of claim interpretation.

What is claimed is:

1. An apparatus, comprising;

a blower housing,

a cooling fan in the blower housing;

a micro-porous panel covering at least part of the blower housing; and

an air gap beneath the micro-porous panel.

2. The apparatus as recited in claim **1** further comprising:

an actuator to dynamically adjust the size of the air gap beneath the micro-porous panel.

3. The apparatus as recited in claim **1** wherein the cooling fan further comprises:

an optimal number of blades having a band pass frequency associated therewith; and

wherein the micro-porous panel characteristics are chosen based on the band pass frequency.